



US EPA RECORDS CENTER REGION 5



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9/18/86
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SEP 24 1986

U.S. EPA, REGION V
WASTE MANAGEMENT DIVISION
HAZARDOUS WASTE ENFORCEMENT BRANCH

September 18, 1986

Mr. Daniel J. Bicknell
Remedial Project Manager
United States Environmental
Protection Agency
Region 5
230 South Dearborn Street
Chicago, Illinois 60604

RE: Reilly Tar, Minnesota

Dear Mr. Bicknell:

Pursuant to receipt of your letter of September 4, 1986, and related telephone conversations concerning the matter of water sample analysis at the Granular Activated Carbon (GAC) treatment facility in St. Louis Park, Minnesota, I have held many long discussions with the City's consultant, Environmental Research & Technology, Inc. (ERT). As I have stated consistently throughout the dialogue, it is the City's intent that the sample analysis be carried out in a responsible fashion in accordance with the provisions of the approved "Quality Assurance Project Plan (QAPP) for Interim Sampling and Analysis, June - August, 1986". In discussing the issues raised in your letter, the City and ERT reviewed, at length, the Agency's position relative to action taken during the analysis and reporting process. We consider the Agency's position to be clear insofar as it is the intent of those responsible that the analysis insure the public that the water discharged by the GAC plant be judged safe to drink by the citizens of St. Louis Park. This position is shared by all parties; however, we, the City and ERT, are concerned the Agency has interpreted actions taken during the analysis/reporting phase to be seriously detrimental to the interpretation of the data presented.

Specifically, the Agency has noted that, "...ERT did not make the appropriate corrective actions as defined in the established QAPP...". Please note three corrective actions are required as established on page 18 of the QAPP. All reports clearly stated which samples were outside the established limits and reported what actions were taken. Insofar as the data table did not contain an asterisk by the data, it is our position that noting the condition in the narrative carried more significance, as it was not treated in passing, rather it was faced "head on". To satisfy all our needs, we will henceforth asterisk appropriate data.

A second Agency concern referred to, "...the four submitted reports did not contain raw analytical data, Chain of Custody (COC) forms, PAH detection

limits, and the out-of-control event forms...". In accordance with QAPP Section 5, ERT's reporting responsibilities were clearly stated. It is our opinion that those responsibilities were met "to the letter"; however, we were unaware of the need to provide the data referenced above. While I respect your perceived need to retain such data, I respectfully request you reconsider your position as it will produce a staggering volume of information which could be readily reviewed via audit. As all parties are aware, ERT has an extensive QA/QC program capable of meeting the rigors of the Contract Laboratory Program audit procedures, and our consultant stands ready to provide all necessary information during such an audit. (As an aside, I have COC forms and I am prepared to release them to the Agency if requested).

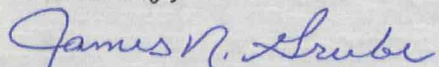
Without doubt, all parties are concerned with the surrogate recoveries reported by ERT. The City, in good faith, represented that the proposed surrogate recovery criteria could be met, based upon discussions with ERT and the Agencies. As data evaluation revealed the recoveries were not within the established limits, the City seriously questioned ERT staff regarding the validity of the procedure and results. As discussions continued, the City became more cognizant of three important points:

1. No EPA Method (neither 625 nor 1625) provides established recovery criteria for surrogate recoveries in part per trillion analysis. Therefore, our part per trillion analysis must either follow EPA Method (1625) criteria for part per billion analysis, or develop a suitable data field to perform meaningful statistical analysis.
2. In the absence of established surrogate recovery criteria, those interested in finding "the answer" are likely to argue many valid points as all strive to gain perspective.
3. ERT analytical staff is extremely confident in the firm's ability to perform. The pride and conscience exhibited by the staff as it "argues its case" leads the City to believe ERT is truly convinced the analytic procedure works and the data is good. The staff appears at odds with others because of conditions 1 and 2 listed above. The City's experiences leads it to believe that when a group exhibits such dogged persistence in defending a position, it is the City's responsibility to listen and reevaluate.

Based upon the considerations raised above, the City respectfully requests the Agencies reevaluate their position of steadfastly maintaining that the proposed surrogate recovery criteria are not to be amended. The City believes the quality of the analytic data (good or bad) does not change because criteria changes. Rather, criteria are an attempt to define data quality. Accordingly, the City considers it appropriate to reconvene the discussions regarding criteria in an attempt to satisfy everyone's desires to find "the answer". The City is not reluctant to admit perspectives change as more information becomes available and it urges all parties to take a similar position.

The City awaits comment from your Agency regarding the information provided and requests made.

Sincerely,


James N. Grube
Director of Public Works

JNG/ja



MEMORANDUM

To: Dan Bicknell (OFFICE)
US EPA (OFFICE)
Region V (OFFICE)
____ (OFFICE)
____ (OFFICE)
____ (OFFICE)

From: Linda M Rogalinski (OFFICE)
Date: 9.23.86 Project No. W63720.FK
Re: Analytical Lab Results, Reilly Tar Site

Enclosed are the analytical laboratory data
for feed and treated water grab samples
collected August 26 and September 9, 1986,
At the St. Louis Park Water Treatment Facility.



CES Date Out: _____

QAO Date Due: _____

9/3

Don/ Norm

Don-
 ① Is this a QAPP? Data Review.
 ② Isn't MPCA taking lead on creeknight? is this US EPA approved QAPP. we should do data review.
 9/3

for your review/comment/approval.

State Minnesota

State-lead _____

Phone

67341

Unit Chief's Initial

DJB

Date

9/3/86

QAPP Prepared By

Requested Due Date

in 30 days _____, in 14 days ☒, in 2 days _____

Analytical Labs Involved

ERT

CLP Lab?

Yes _____, No _____

Need SAS?

Fund-lead Sites Only

Yes _____, No _____

Need Lab Evaluation? PRP-lead Sites Only

Yes _____, No _____

Date Lab Evaluation Done/Will Be Done

Enclosure /Other Documents

QTRAK Form _____, Work Plan _____, Sampling Plan _____, SOP _____

Consent Decree/Order _____, Others Analytical Reports

Other Information

- July 30 and August 7 Reports on GAC drinking water samples analyzed pre QAPP. 2 copies enclosed.

cc. S. Hong, ESU/CES
 T. Rutter, ERRB

To be filled by QAO :

QAO Date In _____
 QAO Log-In No. _____
 Signature _____



A RESOURCE ENGINEERING COMPANY

696 VIRGINIA ROAD, CONCORD, MA 01742, (617) 369-8910

environmental and engineering excellence

ERT Project No. D209-143
ERT Ref. No. 101-JDM-845

August 25, 1986

Mr. James N. Grube
Director of Public Health
City of St. Louis Park
5005 Minnetonka Boulevard
St. Louis Park, MN 55416

RECEIVED

AUG 28 1986

U.S. EPA. REGION 5
WASTE MANAGEMENT DIVISION
WASTE ENFORCEMENT BR.

Dear Mr. Grube:

Enclosed please find seven (7) copies of the report of analysis for the set of water samples submitted from the GAC plant on July 23, 1986.

If you have any questions or comments, please feel free to contact W. Gary Wilson, Thomas Trainor, or me.

Sincerely yours,

Joseph D. Mastone
Laboratory Manager
Analytical Chemistry Services

JDM/r

Enclosure

cc: M. Devine
A. Paradise
T. Trainor
W. G. Wilson
D. Bicknell - US EPA
R. Clark - MN DE
D. Robohm - MN PCA

**ANALYSIS OF TRACE PAH IN WATER SAMPLES
FROM THE CITY OF ST. LOUIS PARK, MN
GAC TREATMENT PLANT**

**ERT Project No. 0005-192
August, 1986**

**Prepared for
Mr. James N. Grube
Director of Public Health
City of St. Louis Park
5005 Minnetonka, Blvd.
St. Louis Park, MN 55416**

**Prepared by
ERT, A Resource Engineering Company
696 Virginia Road, Concord, Massachusetts 01742**

ANALYSIS OF TRACE PAH IN WATER SAMPLES
FROM THE CITY OF ST. LOUIS PARK, MN
GAC TREATMENT PLANT

INTRODUCTION

- This report represents the results of analysis conducted on various water samples received by the ERT Analytical Chemistry Laboratory on July 31, 1986. The samples were to be analyzed for selected polyaromatic hydrocarbons (PAH) and heterocycles.

SAMPLE RECEIPT AND CHAIN OF CUSTODY

Routine inspection of the samples revealed them to be packaged properly and received in good condition.

Upon receipt, information from the submitted samples was recorded in the Master Log Book (and the LIMS computer system) and assigned ERT Control Numbers. These unique sample labels were affixed to respective sample containers and subsequently utilized throughout the laboratory analysis procedures for positive traceability.

ANALYTICAL PROCEDURES

The water samples were analyzed according to procedures as outlined in: ERT Standard Analytical Method (SAM) #020-6 "Analytical Method for Low-level PAH and Heterocycles in Water", as provided in the Quality Assurance Project Plan for Sampling and Analysis - GAC Plant Testing, June-August, 1986, ERT Document No. P-D209-129-1, July, 1986.

QUALITY CONTROL PROCEDURES

Quality control procedures as described in the Quality Assurance Project Plan for Sampling and Analysis - GAC Plant Testing, June-August, 1986, ERT Document No. P-D209-129-1,

July, 1986 were implemented for all analyses. Laboratory method (reagent) blanks, laboratory solvent blanks, laboratory duplicated samples, and laboratory method spike (fortified control) samples were analyzed concurrently with the submitted samples based on the following frequency:

- a) Laboratory method blank, 5% - one for every (20) samples submitted.
- b) Laboratory solvent blank, 10% - one for every (10) samples submitted.
- c) Laboratory method spikes, 5% - one for every (20) samples submitted.

All samples and quality control samples were fortified prior to extraction with selected deuterated PAH surrogate compounds, i.e., naphthalene-d₈, fluorene-d₁₀, and chrysene d-₁₂, at a sample concentration level of approximately 10 ng/l (ppt). The following criteria, based on percent recovery, was to be utilized for the determination of data validity for each sample:

<u>Surrogate</u>	<u>Minimum Mean (%)</u>	<u>Mean (%)</u>	<u>Standard Deviation (%)</u>	<u>95% Confidence Limits</u>
Naphthalene-d ₈	42	72	15	42-102
Fluorene-d ₁₀	60	94	17	60-128
Chrysene-d ₁₂	20	30	12	10-54

Various corrective action steps, as described in the QA plan, were to be initiated whenever the recovery of any one surrogate is found to be below the 95% confidence limit.

RESULTS OF ANALYSIS

The sampling report, analytical results report, the method spike recovery report, and the surrogate recovery report are presented in the attached tables.

No problems were encountered during sample extractions and analyses.

DISCUSSION

A review of naphthalene-d₈ surrogate recoveries indicated that one (1) of the submitted samples was below the 95% confidence interval of 42-102%:

<u>Field Identification</u>	<u>ERT Number</u>	<u>Naphthalene-d₈ % Recovery</u>
F-03	37136	16

The mean recovery for the naphthalene-d₈ surrogate in the samples submitted from the GAC site, including the laboratory method blank and method spike was found to be 49.1%. This value was above the minimum mean value of 42%.

Various corrective action steps, including review of calculations, examination of internal standard and surrogate solutions for degradation and contamination, and an instrument performance check, were performed. These steps did not provide any conclusive insight or explanation for the apparent low recovery of the naphthalene-d₈ surrogate.

In addition, it should be noted that the analytical results for the method spike recovery sample for the eight (8) selected compounds were found to be within the method spike criteria for data validity, except for benzo (g,h,i) perylene which was 4.0% (rather than 10%). However, the average recovery for the target compounds was 46%, within the 20%-150% target range.

The ERT Analytical Laboratory does not feel that the naphthalene-d₈ surrogate recovery (42%) for the one (1) sample compromises the validity of the data as reported. Based on the recovery of the selected PAH compounds in the method spike (matrix fortification) sample, the method is capable of identifying and quantifying the compounds to be analyzed utilizing this analytical method.

**ERT ANALYTICAL LABORATORY
SAMPLING REPORT
CITY OF ST. LOUIS PARK, MN**

ppt ANALYSIS OF PAH IN WATER

ERT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS

1.	FIELD IDENTIFICATION:	T-03
2.	ERT SAMPLE NUMBER:	37135
3.	FIELD LOGBOOK/PAGE NUMBER:	NA
4.	SAMPLING DATE:	7/30/86
5.	DATE RECEIVED:	7/31/86
6.	DATE EXTRACTED:	8/05/86
7.	DATE ANALYZED:	8/20/86
8.	GC/MS FILE #:	37135A
9.	GC/MS TAPE #:	MSD1
10.	CORRESPONDING DFTPP FILE #:	DFTPP10
11.	CORRESPONDING MATRIX SPIKE SAMPLE:	ERT # 37140
12.	CORRESPONDING METHOD BLANK SAMPLE:	ERT # 37286
13.	CORRESPONDING SOLVENT BLANK SAMPLE:	ERT # 37489
14.	CORRESPONDING GC/MS CALIBRATION FILE #:	STD 17
15.	COMMENTS: NA = NOT AVAILABLE	

**ERT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS**

1. FIELD IDENTIFICATION:	F-03
2. ERT SAMPLE NUMBER:	37136
3. FIELD LOGBOOK/PAGE NUMBER:	NA
4. SAMPLING DATE:	7/30/86
5. DATE RECEIVED:	7/31/86
6. DATE EXTRACTED:	8/05/86
7. DATE ANALYZED:	8/20/86
8. GC/MS FILE #:	37136A
9. GC/MS TAPE #:	MSD1
10. CORRESPONDING DFTPP FILE #:	DFTPP10
11. CORRESPONDING MATRIX SPIKE SAMPLE:	ERT # 37140
12. CORRESPONDING METHOD BLANK SAMPLE:	ERT # 37286
13. CORRESPONDING SOLVENT BLANK SAMPLE:	ERT # 37489
14. CORRESPONDING GC/MS CALIBRATION FILE #:	STD 17
15. COMMENTS:	NA - NOT AVAILABLE

**ERT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS**

1. FIELD IDENTIFICATION:	B-03
2. ERT SAMPLE NUMBER:	37137
3. FIELD LOGBOOK/PAGE NUMBER:	NA
4. SAMPLING DATE:	7/30/86
5. DATE RECEIVED:	7/31/86
6. DATE EXTRACTED:	8/5/86
7. DATE ANALYZED:	8/20/86
8. GC/MS FILE #:	37137A
9. GC/MS TAPE #:	MSD1
10. CORRESPONDING DFTFP FILE #:	DFTFP10
11. CORRESPONDING MATRIX SPIKE SAMPLE:	ERT # 37140
12. CORRESPONDING METHOD BLANK SAMPLE:	ERT # 37286
13. CORRESPONDING SOLVENT BLANK SAMPLE:	ERT # 37489
14. CORRESPONDING GC/MS CALIBRATION FILE #:	STD 17
15. COMMENTS:	NA = NOT AVAILABLE

**ERT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS**

1. FIELD IDENTIFICATION:	TD-03
2. ERT SAMPLE NUMBER:	37138
3. FIELD LOGBOOK/PAGE NUMBER:	NA
4. SAMPLING DATE:	7/30/86
5. DATE RECEIVED:	7/31/86
6. DATE EXTRACTED:	8/5/86
7. DATE ANALYZED:	8/19/86
8. GC/MS FILE #:	37138A
9. GC/MS TAPE #:	MSD1
10. CORRESPONDING DFTPP FILE #:	DFTPP09
11. CORRESPONDING MATRIX SPIKE SAMPLE:	ERT # 37140
12. CORRESPONDING METHOD BLANK SAMPLE:	ERT # 37286
13. CORRESPONDING SOLVENT BLANK SAMPLE:	ERT # 37489
14. CORRESPONDING GC/MS CALIBRATION FILE #:	STD 16
15. COMMENTS:	NA - NOT AVAILABLE

**ERT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS**

1. FIELD IDENTIFICATION:	W-03
2. ERT SAMPLE NUMBER:	37139
3. FIELD LOGBOOK/PAGE NUMBER:	NA
4. SAMPLING DATE:	7/30/86
5. DATE RECEIVED:	7/31/86
6. DATE EXTRACTED:	8/05/86
7. DATE ANALYZED:	8/19/86
8. GC/MS FILE #:	37139A
9. GC/MS TAPE #:	MSD1
10. CORRESPONDING DFTPP FILE #:	DFTPP09
11. CORRESPONDING MATRIX SPIKE SAMPLE:	ERT # 37140
12. CORRESPONDING METHOD BLANK SAMPLE:	ERT # 37286
13. CORRESPONDING SOLVENT BLANK SAMPLE:	ERT # 37489
14. CORRESPONDING GC/MS CALIBRATION FILE #:	STD 16
15. COMMENTS:	NA - NOT AVAILABLE

EAT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS

MS-03	1. FIELD IDENTIFICATION:
37140	2. EAT SAMPLE NUMBER:
NA	3. FIELD LOGBOOK/PAGE NUMBER:
7/30/86	4. SAMPLING DATE:
7/31/86	5. DATE RECEIVED:
8/5/86	6. DATE EXTRACTED:
8/19/86	7. DATE ANALYZED:
37140A	8. GC/MS FILE #:
MSD1	9. GC/MS TAP #:
DITFP09	10. CORRESPONDING DITFP FILE #:
EAT # 37140	11. CORRESPONDING MATRIX SPIKE SAMPLE:
EAT # 37286	12. CORRESPONDING METHOD BLANK SAMPLE:
EAT # 37489	13. CORRESPONDING SOLVENT BLANK SAMPLE:
STD-16	14. CORRESPONDING GC/MS CALIBRATION FILE #:
	15. COMMENTS: NA = NOT AVAILABLE

**ERT ANALYTICAL LABORATORY
SAMPLING REPORT
POLYAROMATIC HYDROCARBONS**

1. FIELD IDENTIFICATION:	MB860369
2. ERT SAMPLE NUMBER:	37286
3. FIELD LOGBOOK/PAGE NUMBER:	NA
4. SAMPLING DATE:	NA
5. DATE RECEIVED:	NA
6. DATE EXTRACTED:	8/05/86
7. DATE ANALYZED:	8/19/86
8. GC/MS FILE #:	37286A
9. GC/MS TAPE #:	MSD1
10. CORRESPONDING DFTPP FILE #:	DFTPP09
11. CORRESPONDING MATRIX SPIKE SAMPLE:	ERT # 37140
12. CORRESPONDING METHOD BLANK SAMPLE:	ERT # 37286
13. CORRESPONDING SOLVENT BLANK SAMPLE:	ERT # 37489
14. CORRESPONDING GC/MS CALIBRATION FILE #:	STD 16
15. COMMENTS:	NA = NOT AVAILABLE

**ERT ANALYTICAL LABORATORY
ANALYTICAL RESULTS REPORT
CITY OF ST. LOUIS PARK, MN**

ppt ANALYSIS OF PAH IN WATER

PARAMETERS		CARCINOGENIC PAH'S	
		ANALYTICAL RESULT (NG/L)	
TOTAL CARCINOGENIC PAH		OTHER PAH'S	
QUINOLINE			
BENZO (A) ANTHRACENE			
CHRYSENE			
BENZOFLUORANTHENE			
BENZO (A) PYRENE			
INDENO (1,2,3-CD) PYRENE			
DIBENZ (A,H) ANTHRACENE			
BENZO (G,H,I) PERYLENE			
TOTAL CARCINOGENIC PAH		OTHER PAH'S	
2,3-BENZOFURAN			
2,3-DIHYDROINDENE			
INDENE			
NAPTHALENE			
BENZO (B) THIOPHENE			
INDOLE			
2-METHYLNAPHTHALENE			
1-METHYLNAPHTHALENE			
DIPHENYL			
ACENAPHTHYLENE			
ACENAPHTHENE			
DIBENZOFURAN			
FLUORENE			
DIBENZOTHIOPHENE			
PHENANTHRENE			
ANTHRACENE			
ACRIDINE			
CARBAZOLE			
FLUORANTHENE			
PYRENE			
BENZO (E) PYRENE			
PERYLENE			
TOTAL OTHER PAH		TOTAL PAH'S	
		ND	

**ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
POLYAROMATIC HYDROCARBONS**

FIELD ID: F-03

ERT NO.: 37136

CARCINOGENIC PAH'S

PARAMETERS	ANALYTICAL RESULT (NG/L)
QUINOLINE	4.3
BENZO (A) ANTHRACENE	4.5
CHRYSENE	4.4
BENZOFUORANTHENES	ND
BENZO (A) PYRENE	ND
INDENO (1,2,3-CD) PYRENE	ND
DIBENZ (A,H) ANTHRACENE	ND
BENZO (C,H,I) PERYLENE	ND
TOTAL CARCINOGENIC-PAH	8.8

OTHER PAH'S

2,3-BENZOFURAN	2.9
2,3-DIHYDROINDENE	370
INDENE	20
NAPHTHALENE	ND
BENZO (B) THIOPHENE	120
INDOLE	ND
2-METHYLNAPHTHALENE	ND
1-METHYLNAPHTHALENE	23
BIPHENYL	18
ACENAPHTHYLENE	620
ACENAPHTHENE	900
DIBENZOFURAN	420
FLUORENE	730
DIBENZOTHIOPHENE	95
PHENANTHRENE	100
ANTHRACENE	130
ACRIDINE	38
CARBAZOLE	23
FLUORANTHENE	350
PYRENE	300
BENZO (E) PYRENE	ND
PERYLENE	ND
TOTAL OTHER PAH	4260
TOTAL PAH'S	4269

ENT NO. : 37137

FIELD ID: B-03

CARCINOGENIC PAH'S

ANALYTICAL RESULT

PARAMETERS

QUINOLINE
BENZO (A) ANTHRACENE
CHRYSENE
BENZOFLOANTHRENE
BENZO (A) PYRENE
INDENO (1,2,3-CD) PYRENE
DIBENZ (A,H) ANTHRACENE
BENZO (G,H,I) PERYLENE
TOTAL CARCINOGENIC PAH

OTHER PAGES

ND
ND
ND
ND
ND
ND
ND

2,3-BENZOFURAN
2,3-DIHYDROINDENE
INDENE
NAPHTHALENE
BENZO (B) THIOPHENE
INDOLE

2-METHYLNAPHTHALENE
1-METHYLNAPHTHALENE

BIPHENYL
ACENAPHTHYLENE

ACENAPHTHENE
DIBENZOFURAN
TETRAHYDRO

FLUORENE
DIBENZOTHIOPHENE
DIHYDROFLUORENE

PHENANTHRENE
ANTHRACENE
ACRIDINE

ACRIDINE
CARBAZOLE
ELIMANTHINE

FLUORANTHENE
PYRENE
BENZO (F) PYRENE

PERYLENE

TOTAL OTHER PAN

TOTAL PAGES

ND - Concentration (95% Confidence Interval) of MDL

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
POLYAROMATIC HYDROCARBONS

FIELD ID: TD-03

ERT NO.: 37138

PARAMETERS CARCINOGENIC PAH'S

ANALYTICAL RESULT (NG/L)

PARAMETERS	ANALYTICAL RESULT (NG/L)
QUINOLINE	ND
BENZO (A) ANTHRACENE	ND
CHRYSENE	ND
BENZOFLUORANTHENE	ND
BENZO (A) PYRENE	ND
INDENO (1,2,3-CD) PYRENE	ND
DIBENZ (A,H) ANTHRACENE	ND
BENZO (G,H,I) PERYLENE	ND
TOTAL CARCINOGENIC PAH	ND

OTHER PAH'S

OTHER PAH'S	ANALYTICAL RESULT (NG/L)
2,3-BENZOFURAN	ND
2,3-DIHYDROINDENE	< 3.4
INDENE	ND
NAFTHALENE	ND
BENZO (B) THIOPHENE	ND
INDOLE	ND
2-METHYLNAPHTHALENE	ND
1-METHYLNAPHTHALENE	ND
BIPHENYL	ND
ACENAPHTHYLENE	< 1.7
ACENAPHTHENE	< 1.3
DIBENZOFURAN	ND
FLUORENE	ND
DIBENZOTHIOPHENE	ND
PHENANTHRENE	ND
ANTHRACENE	ND
ACRIDINE	ND
CARBAZOLE	ND
FLUORANTHENE	ND
LYRENE	ND
BENZO (E) PYRENE	ND
PERYLENE	ND
TOTAL OTHER PAH	ND
TOTAL PAH'S	ND

ND = Concentration (95% Confidence Interval of MDL

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
POLYAROMATIC HYDROCARBONS

ERT NO.: 37139

FIELD ID: W-03

ANALYTICAL RESULT
(NG/L)

CARCINOGENIC PAH'S

PARAMETERS

QUINOLINE
BENZO (A) ANTHRACENE
CHRYSENE
BENZOFLUORANTHENE
BENZO (A) PYRENE
INDENO (1,2,3-CD) PYRENE
DIBENZ (A,H) ANTHRACENE
BENZO (G,H,I) PERYLENE
TOTAL CARCINOGENIC PAH

ND

ND
ND
ND
ND
ND
ND
ND

OTHER PAH'S

2,3-BENZOFURAN
2,3-DIHYDRO11SENE
INDENE
NAPHTHALENE
BENZO (B) THIOPHENE
INDOLE
2-METHYLNAPHTHALENE
1-METHYLNAPHTHALENE
BIPHENYL
ACENAPHTHYLENE
ACENAPHTHENE
DIBENZOFURAN
FLUORENE
DIBENZOTHIOPHENE
PHENANTHRENE
ANTHRACENE
ACRIDINE
CARBAZOLE
FLUORANTHENE
PYRENE
BENZO (E) PYRENE
PERYLENE

ND
15
ND
ND
ND
ND
ND
ND
ND
ND
12
17
2.0
6.3

38

ND
ND
3.4

TOTAL OTHER PAH

TOTAL PAH'S

58

ND = Concentration (95% Confidence Interval) of MDL

ERT NO. : 37140

FIELD ID: MS-03

CARCINOGENIC PAH'S

(7/5N)
ANALYTICAL RESULT

PANAMETENS

QUINOLINE
BENZO (A) ANTHRACENE
CHRYSENE
BENZOFLUORANTHENE
BENZO (A) PYRENE
INDENO (1,2,3-CD) PYRENE
DIBENZ (A,H) ANTHRACENE
BENZO (G,H,I) PERYLENE
TOTAL CARCINOGENIC PAH

OTHER PAH'S

130	TOTAL PAH'S
100	TOTAL OTHER PAH
ND	PERYLENE
4.0	BENZO (E) PYRENE
ND	PYRENE
ND	FLUORANTHENE
ND	CARBAZOLE
ND	ACRIDINE
ND	ANTHRACENE
ND	PHENANTHRENE
ND	DIBENZOTHIOPHENE
17	FLUORENE
ND	DIBENZOFURAN
1.5	ACENAPHTHENE
ND	ACENAPHTHYLENE
ND	BIPHENYL
ND	1-METHYLNAPHTHALENE
10	2-METHYLNAPHTHALENE
ND	INDOLE
ND	BENZO (B) THIOPHENE
56	NAPHTHALENE
10	INDENE
4.1	2,3-DIHYDROINDENE
ND	2,3-BENZOFURAN

ND - Concentration (95% Confidence Interval of MDL

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
POLYAROMATIC HYDROCARBONS

FIELD ID: MB860569

ERT NO.: 37286

ANALYTICAL RESULT
(NG/L)

CARCINOGENIC PAH'S

PARAMETERS

QUINOLINE
BENZO (A) ANTHRACENE
CHRYSENE
BENZOFLUORANTHENE
BENZO (A) PYRENE
INDENO (1,2,3-CD) PYRENE
DIBENZ (A,H) ANTHRACENE
BENZO (G,H,I) PERYLENE

TOTAL CARCINOGENIC PAH

ND

OTHER PAH'S

2,3-BENZOFURAN
2,3-DIHYDROINDENE
INDENE
NAPHTHALENE
BENZO (B) THIOPHENE
INDOLE
2-METHYLNAPHTHALENE
1-METHYLNAPHTHALENE
DIPHENYL
ACENAPHTHYLENE
ACENAPHTHENE
DIBENZOFURAN
FLUORENE
DIBENZOTHIOPHENE
PHENANTHRENE
ANTHRACENE
ACRIDINE
CARBAZOLE
FLUORANTHENE
PYRENE
BENZO (E) PYRENE
PERYLENE

TOTAL OTHER PAH

14

TOTAL PAH'S

14

ND = Concentration (95% Confidence Interval of MDL

**ERT ANALYTICAL LABORATORY
METHOD SPIKE RECOVERY REPORT
CITY OF ST. LOUIS PARK, MN**

ppt PAH ANALYSIS IN WATER

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
POLYAROMATIC HYDROCARBONS

FIELD ID: MS-03

ERT NO.: 37140

PARAMETERS	SPIKE LEVEL (NG/L)	% RECOVERY
NAPHTHALENE	110	51
FLUORENE	21	81
CHRYSENE	24	50
BENZO (G,H,I) PERYLENE	22	4.0
INDENE	25	40
QUINOLINE	24	75
BENZO (E) PYRENE	20	20
2-METHYLNAPHTHALENE	21	48
AVERAGE % RECOVERY		46

AVERAGE % RECOVERY TARGET RANGE = 20%-150%

**ERT ANALYTICAL LABORATORY
SURROGATE RECOVERY REPORT
CITY OF ST. LOUIS PARK, MN**

ppt PAH ANALYSIS IN WATER

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SURROGATE RECOVERY REPORT
POLYAROMATIC HYDROCARBONS

FIELD ID: T-03

ERT NO.: 37135

<u>SURROGATE</u>	<u>SPIKE LEVEL</u> <u>(NG/L)</u>	<u>% RECOVERY</u>	<u>95% CONFIDENCE LIMITS</u> <u>(%)</u>
NAPHTHALENE - D8	9.9	42	42-102
FLUORENE - D10	9.5	125	60-128
CHRYSENE - D12	9.8	43	10-54

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SURROGATE RECOVERY REPORT
POLYAROMATIC HYDROCARBONS

FIELD ID: F-03

ERT NO.: 37136

SURROGATE	SPIKE LEVEL (NG/L)	% RECOVERY	95% CONFIDENCE LIMITS (%)
NAPHTHALENE - D8	9.9	✓16	42-102
FLUORENE - D10	9.5	✓138	60-128
CHRYSENE - D12	9.8	21	10-54

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SURROGATE RECOVERY REPORT
POLYAROMATIC HYDROCARBONS

FIELD ID: B-03

ERT NO.: 37137

SURROGATE	SPIKE LEVEL (NG/L)	% RECOVERY	95% CONFIDENCE LIMITS (%)
NAPHTHALENE - D8	9.9	54	42-102
FLUORENE - D10	9.5	✓138	40-128
CHRYSENE - D12	9.8	✓68	10-54

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SURROGATE RECOVERY REPORT
POLYAROMATIC HYDROCARBONS

FIELD ID: TD-03

ERT NO.: 37138

SURROGATE	SPIKE LEVEL (MG/L)	% RECOVERY	95% CONFIDENCE LIMITS (%)
NAPHTHALENE - D8	9.9	58	42-102
FLUORENE - D10	9.5	✓147	60-128
CHRYSENE - D12	9.8	44	10-54

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SURROGATE RECOVERY REPORT
POLYAROMATIC HYDROCARBONS

FIELD ID: W-03

ERT NO.: 37139

SURROGATE	SPIKE LEVEL (NG/L)	% RECOVERY	95% CONFIDENCE LIMITS (%)
NAPHTHALENE - D8	9.9	65	42-102
FLUORENE - D10	9.5	✓166	60-128
CHRYSENE - D12	9.8	37	10-54

ERT ANALYTICAL LABORATORY
 SUMMARY OF ANALYTICAL RESULTS
 SURROGATE RECOVERY REPORT
 POLYAROMATIC HYDROCARBONS

FIELD ID: MS-03

ERT NO.: 37140

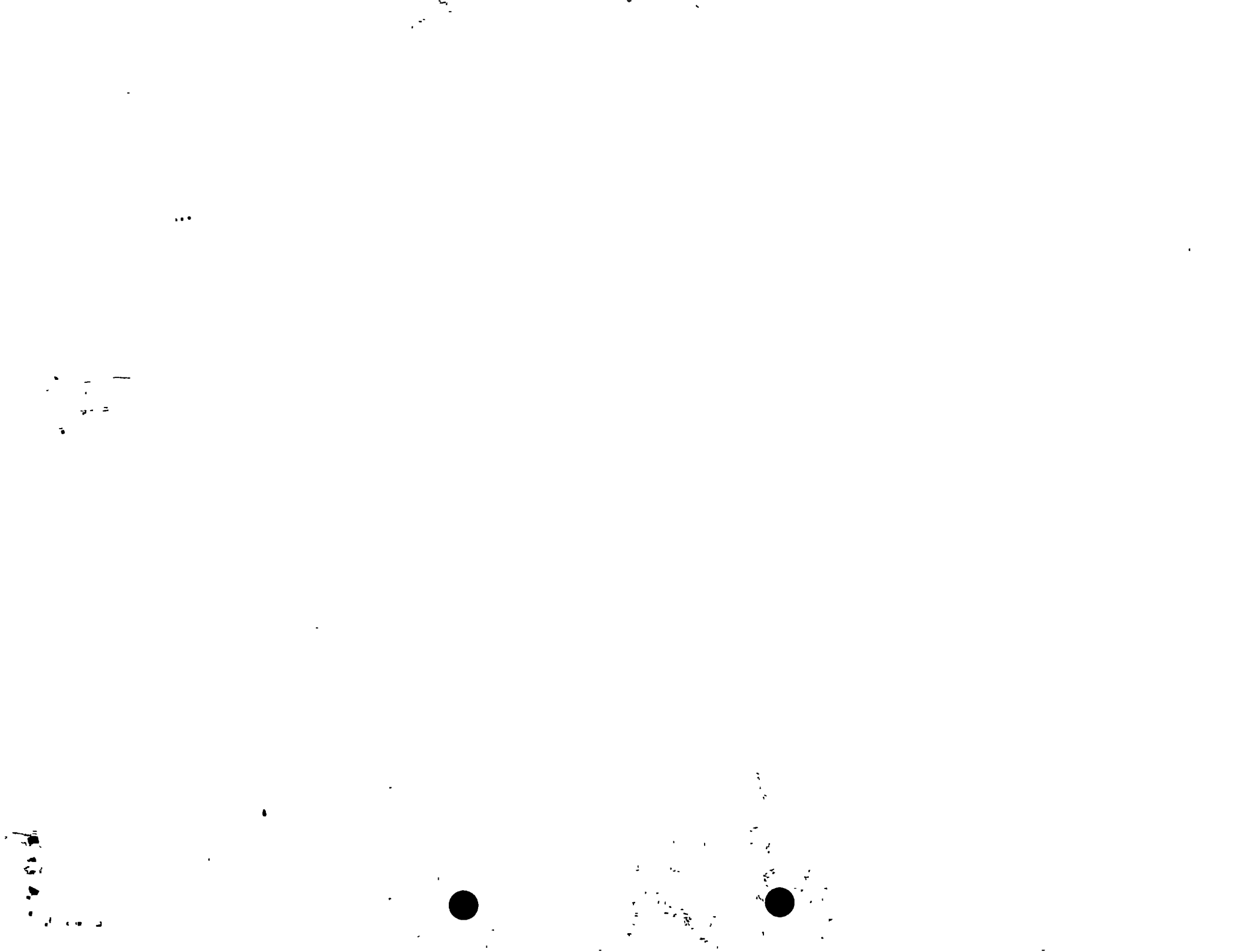
SURROGATE		SPIKE LEVEL		% RECOVERY		95% CONFIDENCE LIMITS	
		(NG/L)				%	
NAPHTHALENE - D8		9.9		64		42-102	
FLUORENE - D10		9.5		145		60-128	
CHRYSENE - D12		9.8		47		10-54	

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SURROGATE RECOVERY REPORT
POLYAROMATIC HYDROCARBONS

FIELD ID: MB860569

ERT NO.: 37286

SURROGATE	SPIKE LEVEL (NG/L)	% RECOVERY	95% CONFIDENCE LIMITS (%)
NAPHTHALENE - D8	9.9	45	42-102
FLUORENE - D10	9.5	116	60-128
CHRYSENE - D12	9.8	83	10-54





FROM: CH2M HILL, INC.
LINDA ROBALINSKI
310 W. Wisconsin Ave. Suite 700
Milwaukee, WI 53201

9/11/86
N.

James Grube
Director of Public Works
City of St. Louis Park
5005 Minnetonka Blvd.
St. Louis Park, MN 55416

DATE September 11, 1986
PROJECT NO. W63720. FR
SUBJECT D.O. measurements
at St. Louis Park

As per our telephone conversation yesterday,
I have enclosed a copy of the dissolved
oxygen measurements taken August 26, 1986,
at the City of St. Louis Park Water Treatment
Facility.

In addition I have included information
on various D.O. meters. Please note on
the sample order form the four (4)
necessary items.

Please contact me if I may be of
further assistance.

Very truly yours,

Linda Robalinski

cc: Dan Bicknell



MEMORANDUM

To: FILE

(OFFICE)

(OFFICE)

From: Linda Royalinski

(OFFICE)

(OFFICE)

Date: 8-28-86 Project No. W63720 ER

(OFFICE)

Re: Belly Tar Site

(OFFICE)

(OFFICE)

On Tuesday, July 26, 1986, Alan Scrivner and I took dissolved oxygen (D.O.) measurements in addition to collecting water samples. The results were as follows:

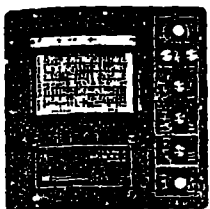
D.O. Feed Water = 1.6 ppm \pm 0.2

Treated Water, Vessel #1 = 0.6 ppm \pm 0.2

Treated Water, Vessel #2 = 0.6 ppm \pm 0.2.

Measurements were made with a YSI D.O. meter, model 5492.

YSI OXYGEN METERS AND MONITORS



G1660-1

G1660-1

MONITOR, Dissolved Oxygen, Continuous, Model 56, YSI- For on-site oxygen and temperature monitoring for pollution discharge studies, fisheries, hatcheries, lake profiling, stream quality studies, etc. Self-contained, portable unit has 2-channel, 4-speed recorder that uses thermal chart paper and a convenient inkless pen. Paper is 100mm wide (4") and 24 meters long with a 100-division linear scale for accurate readings. Unit response time is adjustable from 1 to 18 minutes with ranges of 0-5, 0-10, 0-20 ppm or 0-100% air saturation or 0-100% oxygen saturation. Measures temperatures from -5°C to $+45^{\circ}\text{C}$ and has operation and storage temperature range from -30°C to $+60^{\circ}\text{C}$. Signal output can be used to operate external recorders, meters, alarms or other 0-100 mv devices. Built-in battery pack provides a minimum of 10 days continuous operation per charge, can be continuously line-current operated using the battery charger. A low voltage cutoff protects against inaccurate reading when batteries are low. Watertight case houses power supply, cable and recorder and permits operation regardless of weather conditions. Reusable desiccant capsule in lid protects against condensation damage in the case. Detachable storage reel holds oxygen probe and submersible stirrer with up to 250' of cable. Supplied without oxygen probe, cable assemblies or submersible stirrer. Complete with G1660-11 Oxygen Probe Holder, one roll of G1660-12 Chart Paper, G1660-13 Probe Service Kit, G1660-14 Battery Pack and G1660-15 Charger. Charger operates on 115V, 60 Hz. Dimensions: $13" \times 13" \times 16"$ ($30.5 \times 30.5 \times 40\text{cm}$). Weight 31.5 lbs (15kg).

Order G1660-1-Monitor Each \$3400.00

**ACCESSORIES AND REPLACEMENTS
FOR USE WITH G1660-1 DISSOLVED OXYGEN MONITOR**

G1660-11

OXYGEN PROBE HOLDER (YSI 5601)- Replacement for G1660-1 Monitor. Attaches to cable reel for convenient probe storage.

Order G1660-11-Holder Each \$12.00

G1660-12

CHART PAPER (YSI 5602)- Replacement for G1660-1 Monitor. 1 roll, 24 meters long.

Order G1660-12-Paper Each \$13.00

G1660-13

PROBE SERVICE KIT (YSI 5675)- Replacement for G1660-1 Monitor. Includes 30 probe membranes, 1 x 1 oz. bottle KCl crystals and probe contour tool.

Order G1660-13-Service Kit Each \$15.00

G1660-14

BATTERY PACK (YSI 5603)- Replacement for G1660-1 Monitor.

Order G1660-14-Battery Pack Each \$220.00

G1660-15

BATTERY CHARGER (YSI 5604)- Replacement for G1660-1 Monitor. Operates on 115V, 60 Hz.

Order G1660-15-Charger Each \$110.00

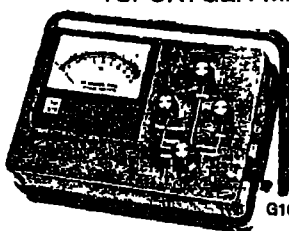
G1660-16

SUBMERSIBLE STIRRER (YSI 5695)- Accessory for G1660-1 Monitor. Assures optimum (1 ft./sec.) water flow rate. Supplied with 50' stirrer-probe cable, but without G1671-6 Probe.

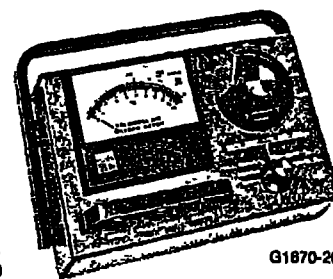
Order G1660-16-Stirrer Each \$420.00

G1670-10

OXYGEN METER, Model 54APB, YSI- For laboratory or field measurement of dissolved oxygen in ppm and $^{\circ}\text{C}$, meter can be calibrated against air or other standard. Dissolved oxygen is measured directly in 0-10 ppm or 0-20 ppm range with $\pm 1\%$ full scale accuracy at calibration temperature; readability is 0.05 ppm and 0.1 ppm respectively. Temperature range is -5° to $+45^{\circ}\text{C}$ with 0.25 $^{\circ}\text{C}$ readability; accuracy is $\pm 0.6^{\circ}\text{C}$. Meter features



G1670-10

G1670-11
G1670-10
G1682-11

G1670-20

automatic temperature compensation accurate to $\pm 1\%$ of D.O. reading made within $\pm 5^{\circ}\text{C}$ of calibration temperature or $\pm 3\%$ of reading from -2° to $+45^{\circ}\text{C}$. Output terminals are provided for recording data. Complete with ABS plastic housing and 4 x 1.35V mercury batteries with approximate 1000-hour life, without probe. Dimensions: $8\frac{1}{2}" \times 11" \times 3\frac{1}{4}"$. Weight 5 $\frac{1}{2}$ lbs.

Order G1670-10-Model 54APB

Each \$588.00

G1670-11

OXYGEN METER, Model 54ARC, YSI- Similar to G1670-10 Oxygen Meter, but with built-in charger and 4 x 1.25V nickel-cadmium rechargeable batteries providing 100 hours of operation between charges. Meter can be operated on line power without damage to unit or batteries. For operation on 117VAC, 50/60 Hz. CSA certified.

Order G1670-11-Model 54ARC

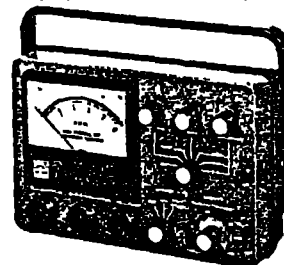
Each \$640.00

G1670-20

OXYGEN METER, Model 51B, YSI- For use in fresh and sea water at a variety of altitudes, meter measures dissolved oxygen from 0-15 ppm and temperature from -5° to $+45^{\circ}\text{C}$ as well as % oxygen and % air saturation. Fresh-to-sea-water dial corrects for salinity, direct dial compensates for atmospheric pressure at altitudes from 0-11,000 feet. Temperature compensation is automatic for membrane coefficient and manual by direct dial for oxygen solubility from 0-45 $^{\circ}\text{C}$ in fresh water and -5° to $+37^{\circ}\text{C}$ in sea water. Accuracy of oxygen measurement is ± 0.2 ppm or better at calibration temperature, readability is 0.1 ppm. Temperature measurements are accurate to $\pm 0.6^{\circ}\text{C}$ with 0.25 $^{\circ}\text{C}$ readability. Complete with ABS plastic housing and 4 disposable "C" size carbon zinc batteries providing 1000 hours of operation, without probe. Dimensions: $8\frac{1}{2}" \times 11" \times 3\frac{1}{4}"$. Weight 3 lbs.

Order G1670-20-Model 51B

Each \$483.00



G1670-30

G1670-30

OXYGEN METER, Model 57, YSI- Portable, battery-operated meter for measuring dissolved oxygen has shock resistant, watertight construction, meter will float if accidentally dropped overboard. Direct reading ranges of 0-5 ppm, 0-10 ppm and 0-20 ppm have respective readabilities of 0.025, 0.05 and 0.1 ppm, accuracy is $\pm 1\%$ full scale at calibration temperature or ± 0.1 ppm, whichever is greater. Temperature range of -5° to $+45^{\circ}\text{C}$ is readable to 0.25 $^{\circ}\text{C}$ with $\pm 0.6^{\circ}\text{C}$ accuracy. Membrane coefficient and change in water temperature are compensated for automatically, accuracy is $\pm 1\%$ of D.O. readings within $\pm 5^{\circ}\text{C}$ of calibration temperature and $\pm 3\%$ of readings from -5° to $+45^{\circ}\text{C}$. Corrections for ocean salinity are made by dialing the salinity concentration, 0-40 ppt. Recorder output is provided for data recording. Complete with ABS plastic housing and 2 disposable "C" size carbon zinc batteries with approximate 1000-hour life, without probe. Dimensions: $8\frac{1}{2}" \times 11" \times 3\frac{1}{4}"$. Weight 3 lbs.

Order G1670-30-Model 57

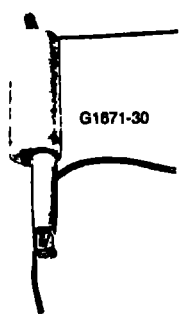
Each \$739.00



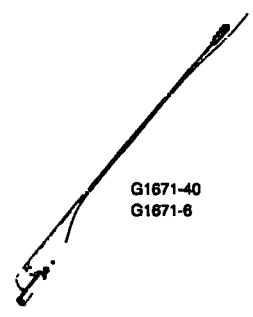
G1670-40



G1671-6
G1682-11



G1671-30



G1671-40
G1671-6

G1670-40 OXYGEN METER, Dissolved, Model 58, YSI—Designed for laboratory and field use. Instrument measures dissolved oxygen with two resolutions including 0 to 20.0 and 0 to 20.00 mg/l, and is accurate to ± 0.03 mg/l. Temperature range is -5° to $+45^{\circ}\text{C}$. Unit also measures % air saturation in gases as well as in many other liquids. In the mg/l range the instrument automatically compensates for membrane coefficient and for changes in oxygen solubility caused by variation in water temperature. The % saturation range is also automatically compensated for membrane coefficient. Other features include easy-to-read LCD display, direct-dial salinity compensation, shock and water resistant gasketed ABS case and recorder output. For field use, meter is powered by four disposable batteries. An additional four batteries can be inserted to power a submersible stirrer. Low battery indication is provided for both sets of batteries. In the lab, meter operates on 115V.
Order **G1670-40—Model 58** Each **\$925.00**

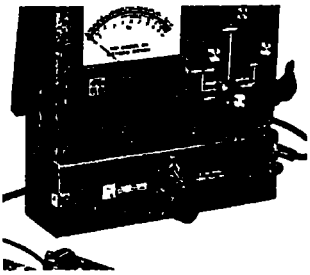
ACCESSORIES FOR YSI OXYGEN METERS

G1671-6 PROBE, Dissolved Oxygen (YSI 5739)—Field probe for measurement of dissolved oxygen features screw-apart construction, allowing change of cable length or replacement of components without replacing entire assembly. Other features include pressure compensation, temperature compensation, built-in weight, polarographic membrane-covered oxygen sensor, protective sensor guard and durable molded plastic construction. Complete with G1671-43 Membrane and KCl Kit. Required for use with G1660-1 Monitor. Can be used with G1660-16 Submersible Stirrer or used alone. When used without submersible stirrer, a G1671-12, -13 or -14 Cable is required. Supplied without cable.
Order **G1671-6—Probe** Each **\$157.00**

G1671-50 BATTERY AND CHARGER PACK (YSI 5721)—For use with G1682-10 or G1682-11 Stirrer when used with G1670-30 Oxygen Meter, internal rechargeable battery power supply is especially useful in field work.
Order **G1671-50—Battery Pack** Each **\$92.00**



G1682-10



G1682-20
with meter and probe

G1682-10 STIRRER, Submersible (YSI 5791A)—For use with G1671-6 Probe and G1671-14 Cable, with 50-foot lead.
Order **G1682-10—Stirrer** Each **\$255.00**

G1682-11 STIRRER, Submersible (YSI 5795A)—For use with G1671-6 Dissolved Oxygen Probe, stirrer features single cable for both stirrer and probe. Requires 6V DC from G1682-20 Battery Pack or directly from stirrer/charger connections on G1670-30 Model 57 Meter, with 50' cable.
Order **G1682-11—Stirrer** Each **\$355.00**

G1682-20 BATTERY PACK, 6-Volt (YSI 5492A)—For use with G1682-10 or G1682-11 Stirrers when used with G1670-10, -11 or -20 Oxygen Meters.
Order **G1682-20—Battery Pack** Each **\$98.00**

CABLE, YSI—For use with G1671-6 Probe, cable is detachable. G1671-14 Cable includes storage reel.

Order	Mtr No	Lgth ft	Each
Cable			
G1671-12	5740-10	10	\$80.00
G1671-13	5740-25	25	98.00
G1671-14	5740-50	50	112.00

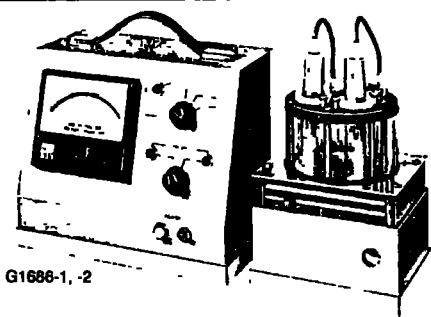
PROBE, B.O.D. Bottle, YSI—For measurement of dissolved oxygen and temperature in the laboratory, probes fit neck of standard B O D bottle or any container with 0.675" diameter opening. G1671-30 Probe has built-in 117VAC, 50/60 Hz stirring motor, stirring must be accomplished manually or with magnetic stirrer for G1671-31 Probe. Complete with G1671-43 Membrane and KCl Kit. G1671-30 Probe is CSA certified.

Order	Mtr No	Description	Each
Probe			
G1671-30	5720	Self-stirring	\$353.00
G1671-31	5750	Nonstirring	190.00

G1671-40 CHAMBER, Field Calibration (YSI 5075)—For use with G1671-6 Probe to make air calibration easier and more accurate, chamber brings probe to temperature of water to be measured in a high humidity air environment at atmospheric pressure. Chamber may also be used for holding probe and stirring sample. Overall length 4 feet.
Order **G1671-40—Chamber** Each **\$99.00**

MEMBRANE AND KCl KIT, YSI—Kits consist of 30 membranes each plus 1 oz dropper bottle of KCl crystals for mixing with distilled water. G1671-43 Kit contains standard membranes for normal dissolved oxygen measurements, G1671-44 Kit contains high sensitivity membranes for measurements at low temperatures and/or low dissolved oxygen levels.

Order	Mtr No	Description	Each
Kit			
G1671-43	5775	Standard	\$8.50
G1671-44	5776	High sensitivity	8.50



G1686-1, -2

BIOLOGICAL OXYGEN MONITOR, Model 53, YSI—Modular system for determination of pO_2 in various biological liquids, unit provides a signal for plotting oxygen uptake or evolution curves directly on any 100 mv recorder. Technic centers on Clark-type polarographic electrode, operating in an atmospherically controlled, compact environment, sensor produces current output proportional to pO_2 , which, for a given solution, at a specific temperature, can be directly related to oxygen concentration. Most determinations require from 2 to 15 minutes, results are obtained much faster than with standard manometric technics. Methodology requires small sample size for completion, for example, one rat hypothalamus will provide material sufficient for many experiments. Testing temperature uniformity must be $\pm 0.02^{\circ}\text{C}$, stirrer is built-in. System consists of G1686-1 Amplifier, G1686-2 Bath-Stirrer Assembly with 2 Lucite plungers, 2 G1686-4 Probe Assemblies and W3220-5 Constant Temperature Water Circulator, all components are necessary for completion of system.

COMPO
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AMPLIF
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COMPONENTS OF BIOLOGICAL OXYGEN MONITORING SYSTEM

G1686-1

AMPLIFIER (YSI 53)—Provides polarizing voltage, probe selection, meter readout and 100 mv recorder output. For operation in 2 ranges: full scale for air at 760mm, and full scale for O₂ at 760mm. CSA certified

Order G1686-1—Amplifier Each \$879.00

G1686-2

BATH ASSEMBLY (YSI 5301)—Offers better than $\pm 0.01^\circ\text{C}$ temperature stability at chamber. Also provides stirring for all 4 chambers

Order G1686-2—Bath Each \$985.00



G1686-4

G1686-4

O₂ PROBE (YSI 5331)—Clark polarographic-type sensor. O₂ consumption 10⁻⁷ grams O₂/hr in air saturated solutions. Design permits sealing O-ring, easy bubble removal, insertion of test materials or inhibitors and operation in gases other than air, if desired. 2 required per instrument

Order G1686-4—Probe Each \$154.00

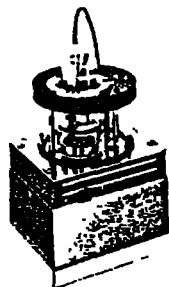
W3220-5

CIRCULATOR, Constant Temperature, Haake—See listing in Water Bath section

G1686-7

CHAMBER PACK (YSI 5215)—Replacement kit for G1686-2 Bath Assembly. Contains 6 precision bore chambers and 12 O-rings

Order G1686-7—Chamber Pack Each \$65.00



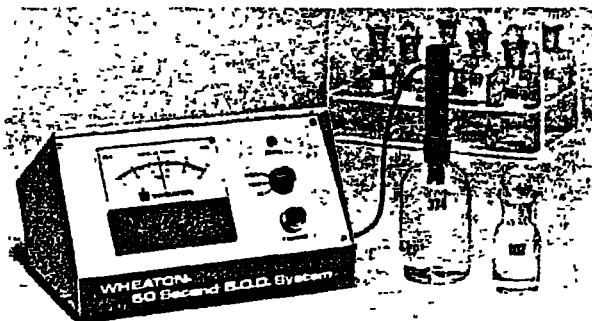
G1686-10

G1686-10

BATH ASSEMBLY, Macro, Model 5302, YSI—Accessory for G1686-1 Amplifier, for use with substrate volumes of 20 to 50ml in studies of oxygen uptake or evolution by small aquatic plants,

animals or large tissue sections. Complete with Lucite plunger, sample chamber and sealing O-rings; incorporates built-in magnetic stirring and provision for maintaining constant bath temperature when used in conjunction with a circulator capable of controlling temperature to an accuracy of $\pm 0.02^\circ\text{C}$. Lucite plunger can be drilled for insertion of other sensors into chamber for additional sample data. For operation on 115V, 60 Hz CSA certified

Order G1686-10—Macro Bath Each \$776.00



G1688-1, -2

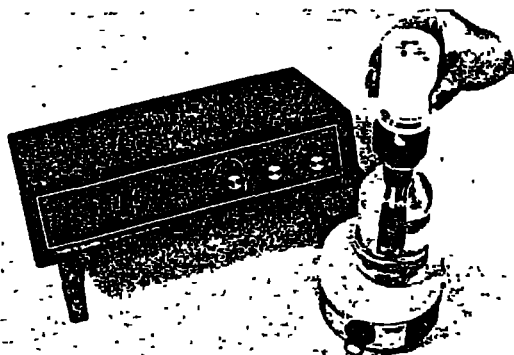
DISSOLVED OXYGEN METER, B.O.D., Wheaton—For determining dissolved oxygen concentrations in liquid waste samples in less than one minute to accuracies comparable to the Winkler method or others employing electrodes, does not require changing of membrane, electrolyte or stirring of sample. Measurement methodology approved by EPA for determining BOD₅ and DO for the National Pollutant Discharger Eliminator System. Unit comes complete with probe, cable, AC line cord and operating instructions including temperature/altitude calibration table

Order Meter	Mfr No	Electrical requirements	Each
G1688-1	227800	95/135VAC, 60 Hz	\$898.00
G1688-2	227802	190/270VAC, 50 Hz	898.00

ACCESSORIES FOR USE WITH G1688-1 and -2
DISSOLVED OXYGEN METER

Order	Mfr No	Description	Each
G1688-11	227805	Probe with 1-2 meter cable & jack	\$329.00
G1688-12	227806	Glass probe storage tube with plastic base	5.25
G1688-13	227808	2 oz conditioning fluid in plastic bottle	2.30

ORION OXYGEN ELECTRODE



G1690-1 with meter

G1690-1

OXYGEN ELECTRODE, Model 9708, Orion—For measurement of oxygen saturation using any pH meter for readout, in most cases in less than 30 seconds. Air calibrated electrode has

concentration range of 0-14 ppm with accuracy of ± 0.05 ppm or 2% of reading and an operating temperature range from 0 to 45°C. The accessory overflow funnel simplifies oxygen measurement and incorporates a captive magnetic stirring bar for sample agitation. Complete with 2 batteries, 2 membrane electrolyte modules, overflow funnel with built-in stirring bar and 1m long cable terminated in standard U.S. plugs for connection to meter. For operation on two silver oxide watch-type batteries. Can provide operation for one year based on 4 hours-per-day use

Order G1690-1—Electrode Each \$495.00

REPLACEMENTS FOR G1690-1 OXYGEN ELECTRODE

G1690-2

MEMBRANE/ELECTROLYTE MODULE (Orion 970801)—For use with G1690-1 Oxygen Electrode

Order G1690-2—Module Each \$25.00

G1690-3

OVERFLOW FUNNEL, With Stirring Bar (Orion 970802)—For use with G1690-1 Oxygen Electrode

Order G1690-3—Funnel Each \$42.00

For batteries see B2606.